

## EZ-Link Sulfo-NHS-LC-Biotin

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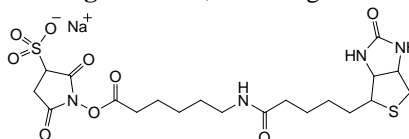
Pub. Part No. 2161855

A39257 21335

Number	Description
21335	<b>EZ-Link Sulfo-NHS-LC-Biotin</b> , 100mg
A39257	<b>EZ-Link Sulfo-NHS-LC-Biotin, No-Weigh Format</b> , 10 × 1mg

Molecular Weight: 556.59

Spacer Arm: 22.4Å



**Storage:** Upon receipt store desiccated at -20°C. EZ-Link Sulfo-NHS-LC-Biotin is shipped at ambient temperature. No-Weigh Format EZ-Link Sulfo-NHS-LC-Biotin is shipped with an ice pack.

**Note:** Product labels have been provided for your convenience. Please label the vials using one of the labels provided in the Al foil pouch to avoid any confusion as you work with this No-Weigh reagent.

## Introduction

The Thermo Scientific™ EZ-Link™ Sulfo-NHS-LC-Biotin (sulfosuccinimidyl-6-[biotin-amido]hexanoate) enables simple and efficient labeling of antibodies, proteins and any other primary amine-containing molecules. Specific labeling of cell surface proteins is another common application for this water-soluble and membrane impermeable reagent. The Thermo Scientific™ No-Weigh™ Format EZ-Link Sulfo-NHS-LC-Biotin consists of convenient single-use vials, eliminating difficulties associated with weighing small quantities of reagent.

Biotin is a vitamin that binds with high affinity to avidin and streptavidin proteins. Because it is small (244Da), biotin can be conjugated to many proteins without altering their biological activities. Labeled proteins can be purified from unlabeled proteins using immobilized streptavidin and avidin and detected in ELISA, dot blot or Western blot applications using streptavidin or avidin-conjugated probes.

N-Hydroxysuccinimide (NHS) esters of biotin are the most popular type of biotinylation reagent. NHS-activated biotins react efficiently with primary amino groups (-NH<sub>2</sub>) in pH 7-9 buffers to form stable amide bonds. Proteins, including antibodies, generally have several primary amines in the side chain of lysine (K) residues and the N-terminus of each polypeptide that are available as targets for labeling with NHS-activated biotin reagents. Several different NHS esters of biotin are available, with varying properties and spacer arm lengths. Sulfo-NHS-LC-Biotin is water soluble, enabling reactions to be performed in the absence of organic solvents such as DMSO or DMF.

Cell-surface biotinylation has emerged as an important tool for studying the expression and regulation of receptors and transporters, differentiation of plasma membrane proteins from those localized to organelle membranes, and distribution of membrane proteins in polarized epithelial cells. The specificity of Sulfo-NHS-LC-Biotin for cell-surface labeling has been demonstrated in these applications.<sup>1,2</sup> Because Sulfo-NHS-LC-Biotin dissolves readily in polar solutions and is charged by the sodium sulfonate group on the succinimidyl ring, it cannot permeate the cell membrane. As long as the cell remains intact, only primary amines exposed on the surface will be biotinylated.

## Important Product Information

- Sulfo-NHS-LC-Biotin is moisture-sensitive. Store the vial of biotin reagent at -20°C with desiccant. To avoid moisture condensation onto the product, equilibrate vial to room temperature before opening.
- No-Weigh format handling: Immediately before use, unscrew the vial, add water and mix by pipetting up and down. Alternatively, the vial can be vortexed for a few seconds to ensure a homogeneous solution. Store the unused vials in the foil pouch provided.

- As directed in the procedure, dissolve the biotin reagent immediately before use. The NHS-ester moiety readily hydrolyzes and becomes non-reactive; therefore, do not prepare stock solutions for storage. Discard any unused reconstituted reagent.
- Avoid buffers containing primary amines (e.g., Tris or glycine) as these will compete with the intended reaction. If necessary, dialyze or otherwise desalt to exchange the protein sample into an amine-free buffer such as phosphate-buffered saline (see Related Thermo Scientific Products).
- When biotinylating proteins in solution, excess non-reacted biotin and reaction byproducts are easily removed by size exclusion using either desalting columns or dialysis. A 10mL desalting column is best suited for processing reactions involving 1-10mg of protein in approximately 0.5-2mL. For smaller protein amounts or reaction volumes, both the biotinylation reaction and subsequent buffer exchange can be performed in a single Thermo Scientific Slide-A-Lyzer MINI Dialysis Unit. For reaction volumes too large for processing with a desalting column, either split the sample between two columns or use an appropriate Thermo Scientific™ Slide-A-Lyzer™ Dialysis Cassette. For processing small volumes (i.e., 10-150µL) of peptides and other low molecular weight molecules, Thermo Scientific™ Pierce™ C18 Spin Columns (Product No. 89870 or 89873) may be used.

## Additional Materials Required

- Phosphate-buffered saline (PBS) or other amine-free buffer having pH 7-8 for use as reaction buffer (see Important Product Information and Related Thermo Scientific Products)
- Desalting columns or dialysis units for buffer exchange (see Important Product Information and Related Thermo Scientific Products)

## Procedure for Biotinylating Proteins in Solution

### A. Calculations

The extent of biotin labeling depends on the distribution of amino groups on the protein, protein concentration and the amount of reagent used. Compared to reactions involving concentrated protein solutions, labeling reactions with dilute solutions require a greater fold molar excess of biotin reagent to achieve the same incorporation level. Experiments performed at Pierce that used a 20-fold molar excess of biotin reagent to label 1-10mg antibody (in 0.5-2mL) resulted in 4-6 biotin groups per antibody molecule. Experiments that used a 50-fold molar excess of biotin reagent to label 50-200µg of antibody (in 200-700µL) resulted in 1-3 biotin groups per antibody molecule. Adjust the molar ratio of Sulfo-NHS-LC-Biotin to protein to obtain the level of incorporation desired.

- Calculate millimoles of biotin reagent to add to the reaction for a 20-fold molar excess:

$$\text{ml protein} \times \frac{\text{mg protein}}{\text{ml protein}} \times \frac{\text{mmol protein}}{\text{mg protein}} \times \frac{20 \text{ mmol Biotin}}{\text{mmol protein}} = \text{mmol Biotin}$$

- 20 = Molar fold excess of biotin

- Calculate microliters of 10mM biotin reagent solution (prepared in Step B.3) to add to the reaction:

$$\text{mmol Biotin} \times \frac{1,000,000 \mu\text{l}}{\text{L}} \times \frac{\text{L}}{10 \text{ mmol}} = \mu\text{l Biotin}$$

**Example:** For 1 ml of 2 mg/ml IgG (150,000 MW), ~27 µl of 10 mM biotin reagent will be added.

$$1 \text{ ml IgG} \times \frac{2 \text{ mg IgG}}{1 \text{ ml IgG}} \times \frac{1 \text{ mmol IgG}}{150,000 \text{ mg IgG}} \times \frac{20 \text{ mmol Biotin}}{1 \text{ mmol IgG}} = 0.000266 \text{ mmol Biotin}$$

$$0.000266 \text{ mmol Biotin} \times \frac{1,000,000 \mu\text{l}}{\text{L}} \times \frac{\text{L}}{10 \text{ mmol}} = 26.6 \mu\text{l Biotin Reagent}$$

## B. Biotin Labeling Reaction

1. Remove vial of Sulfo-NHS-LC-Biotin from freezer and equilibrate it to room temperature before opening in Step 3.
2. Prepare protein in PBS according to the calculation made in Section A.

**Note:** Protein that is already dissolved in amine-free buffer at pH 7.2-8.0 may be used without buffer exchange or dilution with PBS. Proteins in Tris or other amine-containing buffers must be exchanged into a suitable buffer.

3. Immediately before use, prepare a 10mM solution of the biotin reagent:
  - Product No. 21335 (100mg vial): Add 360µL of ultrapure water to 2.0mg of reagent.
  - Product No. A39257 (No-Weigh format): Add 180µL of ultrapure water to the 1mg vial. **The maximum useable volume of the vial is 800µL.**
4. Add the appropriate volume (see Calculations in Section A) of 10mM biotin reagent solution to the protein solution.
5. Incubate reaction on ice for two hours or at room temperature for 30 minutes.
 

**Note:** Other than the possibility of ordinary protein degradation or microbial growth, there is no harm in reacting longer than the specified time.
6. Protein labeling is complete at this point, and although excess non-reacted and hydrolyzed biotin reagent remains in the solution, it is often possible to perform preliminary tests of the labeled protein by ELISA or Western blot. Once proper function and labeling of the protein has been confirmed, for optimal performance and stability, purify the labeled protein using desalting or dialysis. If the Thermo Scientific™ Pierce™ Biotin Quantitation Kit (HABA assay; Product No. 28005) will be performed to determine the level of biotin incorporation, the protein first must be desalted or dialyzed to remove non-reacted biotin.

## Procedure for Biotinylating Cell Surface Proteins

Many variations of this procedure exist in the literature (see General References). Labeling may be performed on cells in suspension or on adherent cells in culture plates. In the latter situation, diffusion of the Sulfo-NHS-LC-Biotin to all surfaces of the cells will be limited, and labeling will occur predominately on the exposed surface. Culture media must be washed from cells; otherwise, amine-containing components will compete and quench the reaction to cell surface proteins. Using a more concentrated cell suspension is most effective because less biotin reagent is required in the reaction. Generally, a final concentration of 2-5mM Biotin Reagent is effective. NHS reactions occur more rapidly at high pH; therefore, pH 8.0 is used in the following example so that labeling can be completed as quickly as possible.

1. Wash cells three times with ice-cold PBS (pH 8.0) to remove amine-containing media and proteins from the cells.
2. Suspend cells at a concentration of  $\sim 25 \times 10^6$  cells/ml in PBS (pH 8.0).
3. Add 1.0mg of Sulfo-NHS-LC-Biotin reagent per mL of cell suspension (results in  $\sim 2$ mM biotin reagent). Alternatively, add 200µL of the 10mM biotin reagent solution (see step B.3 on previous page) per mL of cell suspension.
4. Incubate reaction mixture at room temperature for 30 minutes.

**Note:** Performing this incubation at 4°C may reduce active internalization of the biotin reagent.

5. Wash cells three times with PBS + 100mM glycine to quench and remove excess biotin reagent and byproducts.

## Additional Information Available on the Web

- Tech Tip #14: Perform labeling and other reactions in Slide-A-Lyzer Dialysis Cassettes
- Tech Tip #43: Protein stability and storage
- HABA Calculator for computing the results associated with the HABA assay measurements

## Related Thermo Scientific Products

28372	BupH™ Phosphate Buffered Saline Packs, 40 pack
69576	Slide-A-Lyzer MINI Dialysis Unit Kit, 10 units plus float
66382	Slide-A-Lyzer Dialysis Cassette Kit, 10K MWCO, 3mL
66807	Slide-A-Lyzer Dialysis Cassette Kit, 10K MWCO, 12mL
89892	Zeba™ Spin Desalting Columns, 5mL, 7K MWCO, 25 columns
28005	Pierce™ Biotin Quantitation Kit
20347	Streptavidin Agarose, 2mL
20228	Pierce™ Monomeric Avidin Agarose, 5mL
21126	Streptavidin, Horseradish Peroxidase Conjugated, 1mg
21445	EZ-Link™ Sulfo-NHS-SS-Biotinylation Kit
21935	EZ-Link™ Micro Sulfo-NHS-LC-Biotinylation Kit
89870	Pierce C18 Spin Columns, 25 columns

## Cited References

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# EZ-Link™ Sulfo-NHS-LC-Biotinylation Kit

21435

1776.4

Number	Description
21435	<b>EZ-Link Sulfo-NHS-LC-Biotinylation Kit</b> , sufficient biotin and other reagents for approximately 10 labeling reactions each containing 1-10mg of antibody or other protein <b>Kit Contents:</b> <b>EZ-Link Sulfo-NHS-LC-Biotin</b> , 25mg Molecular Weight: 556.59 Spacer Arm: 22.4Å <b>BupH™ Phosphate Buffered Saline Pack</b> , 1 pack, 0.1M sodium phosphate, 0.15M sodium chloride; pH 7.2 when reconstituted in 500mL of ultrapure water <b>Zeba™ Spin Desalting Columns, 5mL</b> , 10 columns, for 500-2000µL samples, 7000 MWCO <b>HABA</b> , 1mL, 10mM in 0.01N NaOH <b>Affinity Purified Avidin</b> , 10mg  <b>Storage:</b> Upon receipt store vials of biotin reagent and avidin at -20°C. Store remaining kit components kit at 4°C. Kit is shipped at ambient temperature.

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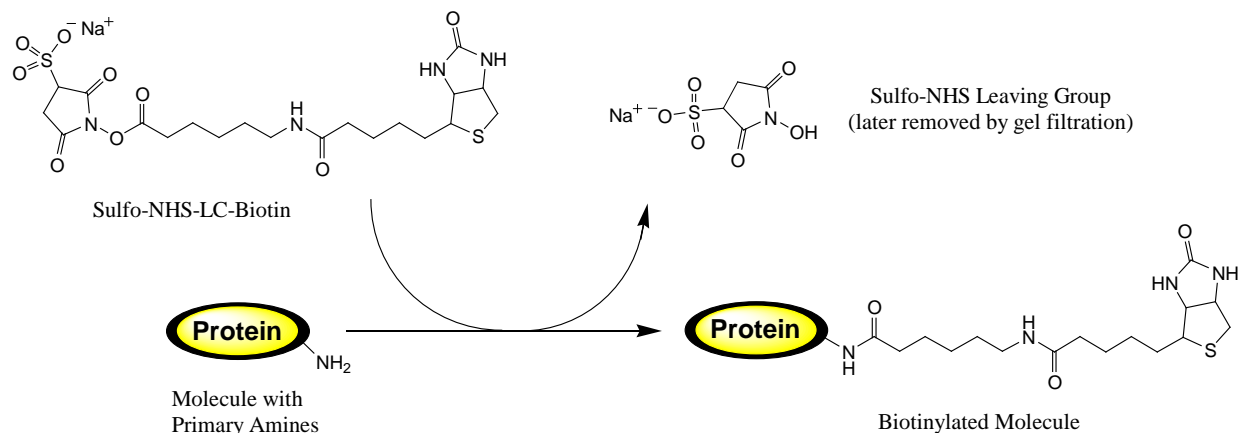
## Introduction

The Thermo Scientific EZ-Link Sulfo-NHS-LC-Biotinylation Kit provides the reagents required for labeling antibodies, proteins and other macromolecules containing primary amino groups with biotin. Besides the biotin reagent and reaction buffer, the kit includes desalting columns for purifying the labeled molecule and HABA and avidin for measuring biotin incorporation. The kit is structured for labeling 1-10mg of protein in a 1mL reaction volume but is easily adapted to smaller or larger scales.

Biotin is a small naturally occurring vitamin that binds with high affinity to avidin and streptavidin proteins. Because of its size (244Da), biotin can be conjugated to many proteins without altering their biological activities. The labeled molecule then can be detected in ELISA, dot blot or Western blot methods using streptavidin or avidin probes.

*N*-Hydroxysuccinimide (NHS) ester-activated biotins are the most popular type of biotinylation reagent. NHS esters react efficiently with primary amino groups ( $-NH_2$ ) in pH 7-9 buffers to form stable amide bonds (Figure 1). Because antibodies and other proteins generally contain multiple lysine (K) residues in addition to the N-terminus of each polypeptide, they have multiple primary amines available as targets for labeling with NHS-activated reagents. EZ-Link Sulfo-NHS-LC-Biotin is water soluble, enabling reactions to be performed in the absence of organic solvents such as DMSO or DMF.

The EZ-Link Sulfo-NHS-LC-Biotinylation Kit combines the basic reagents, tools and easy-to-follow instructions for biotin-labeling amine-containing macromolecules. With this kit, even researchers who have never before labeled antibodies or other proteins can expect to obtain results comparable to those obtained in commercial laboratories.



**Figure 1. Reaction of Sulfo-NHS-LC-Biotin with primary amine.** If drawn to scale, the oval representing the protein would be many times larger than the structures and would likely contain several amino groups. Note that NHS is a leaving group (byproduct) in the reaction. The leaving group and any non-reacted biotin reagent are removed during the desalting step.

## Important Product Information

- Sulfo-NHS-LC-Biotin is moisture-sensitive. Store the vial of biotin reagent at  $-20^{\circ}\text{C}$  with desiccant. To avoid moisture condensation onto the product, equilibrate vial to room temperature before opening.
- As directed in the procedure, dissolve the biotin reagent immediately before use. The NHS-ester moiety readily hydrolyzes and becomes non-reactive; therefore, weigh and dissolve only a small amount of the reagent at a time, and do not prepare stock solutions for storage. Discard any unused reconstituted reagent.
- Avoid buffers containing primary amines (e.g., Tris or glycine) as these will compete with the reaction (see Figure 1). If necessary, dialyze or otherwise desalt to exchange the protein sample into an amine-free buffer such as phosphate-buffered saline (one packet is included in this kit).
- The desalting columns provided in this kit are best suited for processing biotinylation reactions involving 1-10mg of protein in approximately 0.5-2mL. For smaller amounts of protein and/or smaller reaction volumes, perform both the biotinylation reaction and buffer exchanges in a single Thermo Scientific Slide-A-Lyzer MINI Dialysis Unit. For reaction volumes that are larger than can be processed with a desalting column, split the sample between two columns or use an appropriate Slide-A-Lyzer™ Dialysis Cassette for buffer exchanges. For processing small volumes (i.e. 10-150  $\mu\text{L}$ ) of peptides and other low molecular weight molecules, the Thermo Scientific Pierce C18 Spin Columns (Product No. 89870 or 89873) may be used.

## Procedure for Biotinyating Proteins

### A. Calculations

The extent of biotin labeling depends on the size and distribution of amino groups on the protein and the amount of reagent used per protein concentration. Compared to reactions involving concentrated protein solutions, labeling reactions with dilute protein solutions require a greater fold molar excess of biotin reagent to achieve the same incorporation level. Experiments that used a 20-fold molar excess of biotin reagent to label 1-10mg/mL antibody (IgG) resulted in 4-6 biotin groups per antibody molecule. Adjust the molar ratio of Sulfo-NHS-LC-Biotin to protein to obtain the level of incorporation desired. Instructions for using Sulfo-NHS-LC-Biotin (Product No. 21335) for labeling cells is available for download from the web site.

1. Calculate millimoles of Sulfo-NHS-LC-Biotin to add to the reaction for a 20-fold molar excess:

$$\text{mL protein} \times \frac{\text{mg protein}}{\text{mL protein}} \times \frac{\text{mmol protein}}{\text{mg protein}} \times \frac{20 \text{ mmol Biotin}}{\text{mmol protein}} = \text{mmol Biotin}$$

- 20 = Recommended molar fold excess of biotin per 1-10mg/mL protein sample

2. Calculate microliters of 10mM Sulfo-NHS-LC-Biotin (prepared in Step B.3) to add to the reaction:

$$\text{mmol Biotin} \times \frac{557 \text{ mg}}{\text{mmol Biotin}} \times \frac{400 \mu\text{L}}{2.2 \text{ mg}} = \mu\text{L Biotin Solution}$$

- 557 = Molecular weight of Sulfo-NHS-LC-Biotin
- 400 = Microliters of water in which 2.2mg of Sulfo-NHS-LC-Biotin is dissolved to make a 10mM solution

**Example:** For 1mL of a 2mg/mL IgG (150,000 MW) solution, ~27μL of 10mM Sulfo-NHS-LC-Biotin will be added.

$$1 \text{ mL IgG} \times \frac{2 \text{ mg IgG}}{1 \text{ mL IgG}} \times \frac{1 \text{ mmol IgG}}{150,000 \text{ mg IgG}} \times \frac{20 \text{ mmol Biotin}}{1 \text{ mmol IgG}} = 0.000266 \text{ mmol Biotin}$$

$$0.000266 \text{ mmol Biotin} \times \frac{557 \text{ mg}}{\text{mmol Biotin}} \times \frac{400 \mu\text{L}}{2.2 \text{ mg}} = 26.9 \mu\text{L Biotin Solution}$$

## B. Biotin Labeling Reaction

1. Remove the vial of Sulfo-NHS-LC-Biotin from freezer and equilibrate it to room temperature before opening in step 3.
2. Dissolve 1-10mg protein in 0.5-2mL of phosphate-buffered saline (PBS) according to the calculation made in section A. Prepare the Thermo Scientific BupH PBS as directed on the package label.

**Note:** Protein already dissolved in amine-free buffer at pH 7.2-8.0 may be used without buffer exchange. Proteins in Tris or other amine-containing buffers must be exchanged into PBS. Perform buffer exchange of 0.5-2.0 ml samples by dialysis or using one of the desalting columns included in this kit, as described in Section C. Be aware that this kit contains only 10 single-use desalting columns, sufficient for 10 biotinylation procedures when used only for Section C.

3. Immediately before use, prepare 10mM Sulfo-NHS-LC-Biotin by dissolving 2.2mg in 400μL ultrapure water.
4. Add the appropriate volume of Sulfo-NHS-LC-Biotin solution (see calculations in Section A) to the protein solution.
5. Incubate reaction on ice for two hours or at room temperature for 30-60 minutes.

**Note:** There is no harm in reacting longer than the specified time other than the possibility of ordinary protein degradation or microbial growth.

**Note:** Although excess non-reacted and hydrolyzed biotin reagent remains in the solution, it is often possible to perform preliminary tests of the labeled protein by ELISA or Western blot. Once function has been confirmed, buffer exchange the labeled protein for optimal performance and stability using the procedure in Section C: Buffer Exchange using a Desalting Column. If the HABA Assay will be performed to determine biotin incorporation, the protein must be purified by buffer exchange first.

## C. Buffer Exchange and Remove Excess Biotin Reagent Using a Desalting Column

1. Prepare a Thermo Scientific Zeba Spin Desalting Column by breaking off the bottom plug and placing the column into a 15mL collection tube. Centrifuge the column at 1000 × g for 2 minutes, discard the storage buffer and return column to the same collection tube. Place a mark on the side of the column where the compacted resin is slanted upward. Place column in centrifuge with the mark facing outward in all subsequent centrifugation steps.

2. Equilibrate the column by adding 2.5mL of PBS to the top of the resin bed and centrifuging at  $1000 \times g$  for 2 minutes. Discard the flow-through and repeat this step a total of 2-3 times.
3. Place column into a new 15mL collection tube and apply the protein sample directly onto the center of the resin bed. Allow sample to absorb into the resin.  
**Note:** For samples  $< 1000\mu\text{L}$ , add  $100\mu\text{L}$  ultrapure water on top of the absorbed sample to increase protein recovery.
4. Centrifuge the column at  $1000 \times g$  for 2 minutes. The collected flow-through solution is the purified protein sample. Store the protein solution in appropriate conditions.

## HABA Assay for Measuring the Level of Biotin Incorporation

To estimate biotin incorporation, a solution containing the biotinylated protein is added to a mixture of HABA and avidin. Because of its higher affinity for avidin, biotin displaces the HABA from its interaction with avidin and the absorbance at 500nm decreases proportionately. An unknown amount of biotin present in a solution is estimated in a single cuvette by measuring the absorbance of the HABA-avidin solution before and after addition of the biotin-containing sample. The change in absorbance relates to the amount of biotin in the sample.

**Note:** The biotin-labeled protein sample must be desalted or dialyzed to remove all traces of non-reacted and hydrolyzed biotinylation reagent before the HABA assay is performed.

### A. Reagent Preparation

Phosphate-buffered Saline (PBS)	100mM sodium phosphate, 150mM sodium chloride; pH 7.2; Product No. 28372  <b>Note:</b> Avoid buffers containing potassium (e.g., Modified Dulbecco's PBS), which will cause precipitation in the assay. Empirically determine if other buffers are compatible by comparing to results obtained using TBS or PBS.
HABA/Avidin Solution	Add 10mg of avidin and $600\mu\text{L}$ of 10mM HABA to 19.4mL of PBS. If prepared correctly, the $A_{500}$ of this solution will be 0.9-1.3 in a 1cm cuvette. The solution is stable for two weeks at $4^{\circ}\text{C}$ . If a precipitate forms in the HABA solution, it can be filtered and then used.

### B. Procedure for Estimating Biotin Incorporation

#### • Procedure Option 1 – Cuvette Format

1. Pipette  $900\mu\text{L}$  of HABA/Avidin Solution into a 1mL cuvette.
2. Measure the absorbance of the solution in the cuvette at 500nm and record the value as  $A_{500}$  HABA/Avidin.
3. Add  $100\mu\text{L}$  of biotinylated protein sample to the cuvette containing HABA/Avidin and mix well.
4. Measure the absorbance of the solution in the cuvette at 500nm. Once the value remains fairly constant for at least 15 seconds, record the value as  $A_{500}$  HABA/Avidin/Biotin Sample. If the  $A_{500}$  HABA/Avidin/Biotin is  $< 0.3$ , dilute the biotinylated protein sample and repeat the assay, but remember to account for the dilution in during calculations.
5. Proceed to Section C: Calculation of Moles of Biotin per Mole of Protein.

#### • Procedure Option 2 – Microplate Format

1. Pipette  $180\mu\text{L}$  of HABA/Avidin Solution into a microplate well.
2. Measure the absorbance at 500nm of the solution in the well and record the value as  $A_{500}$  HABA/Avidin.
3. Add  $20\mu\text{L}$  of biotinylated sample to the well containing the HABA/Avidin Solution. Mix the plate using an orbital shaker or plate mixer.
4. Measure the absorbance at 500nm of the solution in the well. Once the value remains fairly constant for at least 15 seconds, record the value as  $A_{500}$  HABA/Avidin/Biotin Sample.
5. Proceed to Section C: Calculation of Moles of Biotin per Mole of Protein.



### C. Calculations for Moles of Biotin per Mole of Protein

**Note:** An automatic HABA Calculator is available at the website for performing these calculations.

These calculations are based on the Beer Lambert Law (Beer's Law):  $A_{\lambda} = \epsilon_{\lambda} b C$

Where:

**A** is the absorbance of the sample at a particular wavelength ( $\lambda$ ). The wavelength for the HABA assay is 500nm. There are no units for absorbance.

$\epsilon$  is the absorptivity or extinction coefficient at the wavelength ( $\lambda$ ). For HABA/avidin samples at 500nm, pH 7.0 extinction coefficient is equal to  $34,000\text{M}^{-1}\text{cm}^{-1}$ .

**b** is the cell path length expressed in centimeters (cm). A 10mm square cuvette has a path length of 1.0cm. Using the recommended microplate format volumes, the path length is typically 0.5cm.

**C** is the concentration of the sample expressed in molarity (= mol/L = mmol/mL).

The values needed for calculating the number of moles of biotin per mole of protein or sample are as follows:

- Concentration of the protein or sample used, expressed as mg/ml
- Molecular weight (MW) of the protein, expressed as grams per mole (e.g., HRP = 40,000; IgG = 150,000)
- Absorbance at 500nm for HABA/Avidin Solution ( $A_{500} \text{ H}\backslash\text{A}$ )
- Absorbance at 500nm for HABA/Avidin/Biotin reaction mixture ( $A_{500} \text{ H}\backslash\text{A}\backslash\text{B}$ )
- Dilution factor, if the sample is diluted before adding it to the HABA/Avidin Solution

1. Calculation #1 is for the concentration of biotinylated protein in mmol/ml (before any dilution for the assay procedure):

$$\text{mmol protein per mL} = \frac{\text{protein concentration (mg/mL)}}{\text{MW of protein (mg/mmol)}} = \text{Calc\#1}$$

2. Calculation #2 is for the change in absorbance at 500nm:

- Cuvette:

$$\Delta A_{500} = (0.9 \times A_{500} \text{ H}\backslash\text{A}) - (A_{500} \text{ H}\backslash\text{A}\backslash\text{B}) = \text{Calc\#2}$$

- Microplate:

$$\Delta A_{500} = (A_{500} \text{ H}\backslash\text{A}) - (A_{500} \text{ H}\backslash\text{A}\backslash\text{B}) = \text{Calc\#2}$$

**Note:** The cuvette format requires the 0.9 correction factor to adjust for dilution of the H\A Solution by the biotinylated protein sample. The microplate format does not require this correction factor because the dilution effect is exactly offset by the increased height and light path length of solution in the well.

3. Calculation #3 is for the concentration of biotin in mmol per ml of reaction mixture:

$$\frac{\text{mmol biotin}}{\text{mL reaction mixture}} = \frac{\Delta A_{500}}{(34,000 \times b)} = \frac{\text{Calc\#2}}{(34,000 \times b)} = \text{Calc\#3}$$

**Note:** **b** is the light path length (cm) of the sample. Use **b** = 1 with the cuvette format. Use **b** = 0.5 with the microplate format when using a standard 96-well plate and the volumes specified in the procedure. The exact path length is the height of the solution through which the plate reader measures the absorbance.

4. Calculation #4 is for the mmol of biotin per mmol of protein:

$$\begin{aligned} &= \frac{\text{mmol biotin in original sample}}{\text{mmol protein in original sample}} \\ &= \frac{(\text{mmol per mL biotin in reaction mixture})(10)(\text{dilution factor})}{\text{mmol per mL protein in original sample}} \\ &= \frac{(\text{Calc\#3}) \times 10 \times \text{dilution factor}}{\text{Calc\#1}} \end{aligned}$$

**Note:** The original biotinylated protein sample was diluted 10-fold in the reaction mixture. Therefore, a multiplier of 10 is used in this step to convert the biotin concentration in the reaction mixture to the biotin concentration in the original sample. If the original sample was diluted before performing the assay, then the dilution factor must be used as well. Calculation #4 yields the biotin:protein molar ratio (average # of biotin molecules per protein molecule).

**Example HABA Assay calculation:** In this example, the labeled protein is IgG (MW 150,000) at 0.69 mg/mL. The absorbance measurements were  $A_{500} \text{ H\A} = 0.904$  and  $A_{500} \text{ H\A\B} = 0.771$ .

1.  $\text{mmol biotinylated protein per mL} = \frac{0.69 \text{ mg/mL}}{150,000 \text{ mg/mmol}} = 4.6 \times 10^{-6}$
2.  $\Delta A_{500} = (0.9 \times 0.904) - 0.771 = 0.0426$
3.  $\frac{\text{mmol biotin}}{\text{mL reaction mixture}} = \frac{0.0426}{34,000} = 1.25 \times 10^{-6}$
4.  $\frac{\text{mmol biotin}}{\text{mmol protein}} = \frac{(1.25 \times 10^{-6}) \times 10}{4.6 \times 10^{-6}} = \frac{12.5 \times 10^{-6}}{4.6 \times 10^{-6}} = 2.72 \text{ biotin molecules per IgG molecule}$

## Troubleshooting the HABA Assay

Problem	Cause	Solution
$\Delta A_{500}$ in HABA assay is $\leq 0$	The protein sample has no or a low level of biotinylation because of limited accessible functional groups on the protein	Repeat biotinylation with alternative chemistry (e.g., sulfhydryl-reactive) or use a higher molar ratio of biotinylation reagent
	Incomplete mixing of reagent	Completely solubilize and mix HABA/Avidin before diluting
	Particles in sample contribute to absorbance	Filter protein sample to remove particles
High levels of biotinylation	Nonreacted biotin was not removed	Dialyze or desalt sample before performing the assay

## Additional Information

Please visit the website for additional information including the following:

- HABA Calculator for computing the results associated with the HABA Assay measurements
- Tech Tip #14: Perform labeling and other reactions in Slide-A-Lyzer Dialysis Cassettes

## Related Thermo Scientific Products

21335	EZ-Link Sulfo-NHS-LC-Biotin, 100mg
69576	Slide-A-Lyzer MINI Dialysis Unit Kit
66382	Slide-A-Lyzer Dialysis Cassette Kit
20347	Streptavidin Agarose Resin, 2mL
21126	Streptavidin, Horseradish Peroxidase Conjugated, 1mg
89870	Pierce® C18 Spin Columns, 25 columns

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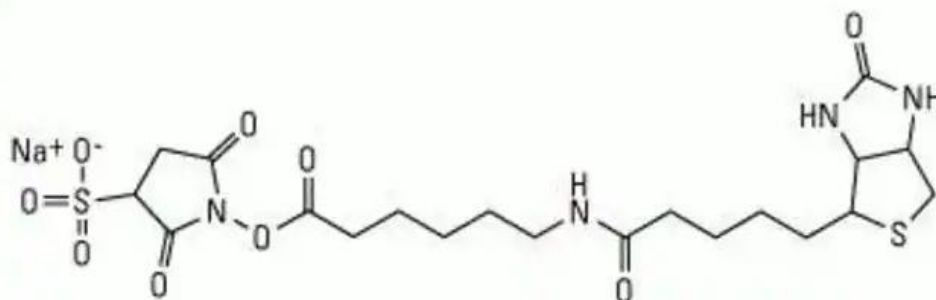
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	Sulfo-NHS-Biotin	Sulfo-NHS-LC-Biotin	Sulfo-NHS-LC-LC-Biotin
Molecular formula	C <sub>14</sub> H <sub>18</sub> O <sub>8</sub> N <sub>3</sub> S <sub>2</sub> Na	C <sub>20</sub> H <sub>29</sub> O <sub>9</sub> N <sub>4</sub> S <sub>2</sub> Na	C <sub>26</sub> H <sub>40</sub> O <sub>10</sub> N <sub>5</sub> S <sub>2</sub> Na
Molecular weight	443.43	556.59	669.75
Spacer arm length	13.5 angstroms	22.4 angstroms	30.5 angstroms
Mass added to target	226.3 daltons	339.5 daltons	452.6 daltons
CAS number	119616-38-5	127062-22-0	N/A
Form	White to off-white powder	White to tan powder	White to off-white powder
SMILES structures	<chem>O=C(CC1S([O-])(=O)=O)N(OC(CCCCC(SC2)C3C2NC(N3)=O)=O)C1=O.[Na+]</chem> <chem>O=C(CCCCCNC(CCCCC(SC1)C2C1NC(N2)=O)=O)ON3C(CC(S([O-])(=O)=O)C3=O)=O.[Na+]</chem> <chem>O=C(CC1S([O-])(=O)=O)N(OC(CCCCCNC(CCCCCNC(CCCCC(SC2)C3C2NC(N3)=O)=O)=O)C1=O.[Na+]</chem>		
Storage conditions	-20°C with desiccant, protect from moisture, use only fresh solutions		
Reactive groups	N-hydroxysuccinimide ester, reacts with primary amines at pH 7.0-9.0		

Chemical structure of Sulfo-NHS-LC-Biotin



Sulfo-NHS-LC-Biotin

MW 556.59

Spacer Arm 22.4 Å